ment of the columns, therefore, differs from those previously published.

Meteorological observations at Honolulu.

JANUARY, 1899.

The station is at 21° 18′ N., 157° 50′ W.; altitude 50 feet.

Pressure is corrected for temperature and reduced to sea level, and the gravity correction, −0.06, has been applied.

The average direction and maximum force of the wind and the average cloudiness for the whole day are given unless they have varied more than usual, in which case the extremes are given. The scale of wind force is 0 to 12, or Beaufort scale. Two directions of wind, or values of wind force, connected by a dash, indicate change from one to the other.

The rainfall for twenty-four hours is now given as measured at 1 p. m. Greenwich time on the respective dates.

The rain gauge, 8 inches in diameter, is 1 foot above ground. Thermometer, 9 feet above ground. Ground is 50 feet above sea level.

Date.	Pressure at sea level.	Temperature.		During twenty-four hours preceding 1 p. m. Greenwich time.									
				Temperature.		Means.		Wind.				Sea-level pressures.	
		Dry bulb.	Wet bulb.	Maximum.	Minimum.	Dew-point.	Relative humidity.	Prevailing direction.	Maximum force.	Total rainfall.	Average cloudiness.	Maximum.	Minimum.
	*	†	†			‡	‡		§				
1	29.99	67	65	80	68	65.0	81	se.	1	0.00	1-10	30.01	29.94
2	29.98	67	65	80	65	65.7	79	ne.	3	0.00	8-0	30.05	29.97
3	29.95	67	66	78	64	65.0	79	ne.	2	0.00	6	30.01	29.92
4	29.98	63	62	81	65	66.0	85	ne-nw.	2	0.32	6	30.00	29.94
5	29.95	68	65	78	63	62.5	75	nne-se.	1	0.00	1	30.04	29.92
6	29.98	65	64.5	78	65	64.3	79	ne-se.	1	0.00	6-1	30.00	29.91
7	29.98	66	65	78	63	66.7	85	s-sw.	1	0.04	2-8	29.99	29.90
8	30.07	70	66	78	65	67.3	86	sw.	1	0.39	2	30.07	29.98
9	30.07	71	65	79	65	64.5	73	ne.	2	0.00	1	30.13	30.02
10	30.02	69	65	76	65	59.7	63	nne.	3	0.00	5-1	30.12	30.02
11	30.01	72	65	76	67	63.0	74	ne.	5	0.02	3	30.05	29.98
12	30.00	65	62	79	69	61.3	64	ne.	3	0.00	5	30.06	29.97
13	30.00	68	65	79	63	61.7	73	e.	1	0.00	1	30.02	29.97
14	30.05	61	59	80	64	62.3	72	sw.	1	0.00	2	30.02	29.96
15	30.11	69	65	79	60	61.7	75	sw-ne.	1	0.00	0-1	30.11	30.00
16	30.10	71	66	80	65	63.0	70	ne.	3	0.05	5-3	30.16	30.06
17	30.07	71	65	78	69	63.3	71	ne.	3	0.05	5	30.15	30.06
18	30.01	65	63	77	69	62.7	69	ne.	3	0.00	6	30.11	30.00
19	29.94	61	60	79	63	62.3	78	nne.	2	0.00	5	30.05	29.92
20	29.99	60	59	79	60	60.5	73	s.	1	0.00	0-5	30.01	29.94
21	29.98	66	63.5	80	59	62.3	76	ne.	2	0.00	2-5	30.07	29.95
22	29.96	69	63.5	79	61	61.7	69	nne.	2	0.00	2-6	30.06	29.95
23	29.93	64	62	79	69	59.3	65	se-e.	2	0.00	1-4	29.99	29.89
24	29.93	62	61	80	63	61.8	72	se-s.	2	0.00	1	29.98	29.87
25	29.92	67	66	79	61	63.5	78	se-sw.	2	0.28	1-3	29.97	29.88
26	29.97	60	57	78	64	61.7	78	w-nw.	3	0.00	10-0	29.96	29.88
27	29.99	63	59	74	59	55.0	70	n.	2	0.01	1	30.04	29.94
28	29.93	62	59	75	56	56.0	70	nne.	3	0.00	4	30.02	29.91
29	29.90	63	60.5	75	61	57.7	65	nne.	3	0.03	2-4	29.94	29.84
30	29.84	63	61	75	61	59.7	69	nne.	3	0.01	3-1	29.92	29.82
31	29.84	64	63	79	61	62.8	77	ne-e.	2	0.02	3-6	29.89	29.82
Sums	......	......	......	......	......	......	......	....	.....	1.22	.....	....	.....
Means.	29.981	65.8	63.0	78.0	63.4	62.2	73.9	....	‖	....	¶	30.030	29.935
Departure	+ 0.3	......	......	......	......	0.0	−1.1	....	.....	−2.05	.....	....	.....

Mean temperature for January, 1899 $(6+2+9)\div3=70.4°$; normal is 70.0°. Mean pressure for January is 29.98; normal is 29.95.

* This pressure is as recorded at 1 p. m., Greenwich time. † These temperatures are observed at 6 a. m., local, or 4:30 p. m., Greenwich time. ‡ These values are the means of $(2+9+6)\div4$. § Beaufort scale. ‖ Mean for the daytime is 2.0. ¶ The mean during daylight is 3.6.

THE NORTHWEST GALES OF THE SOUTHERN BLUE RIDGE AND PIEDMONT REGION.

By BARRY C. HAWKINS, Voluntary Observer, Horse Cove, Highlands, N. C.

At first thought it would seem easy to divide all the winds of the globe into two classes, viz, (1) *general*, such as occur over all the sphere, as the general circulation of the atmosphere, cyclones, anticyclones, etc., (2) *local*, such as the sea breeze occurring where conditions favor or permit, and other local phenomena such as the "bora" wind occurring only in one or a few localities. But when we look deeper we find there are no atmospheric movements confined to one place, and that the features called "local" are repeated wherever the conditions are such as to produce them.

The foehn wind is not confined to Switzerland, but is well known on the North American continent, as the chinook wind. As Professor Abbe has pointed out many times in the MONTHLY WEATHER REVIEW,[1] dynamic heating occurs not only in the chinook wind but on the south side of every cyclone, and in general whenever some air ascends and cools other air must descend and be warmed. Some do not seem ready to admit this warming, although they ascribe much to the cooling by the ascent of air.

The winds I shall describe are perhaps not specially local, but so far as I know they have not been described. These winds are severe northwest gales, occurring on the eastern slope of the southern Blue Ridge Mountains, and extending into the Piedmont region for at least 50 miles. The time of occurrence is the winter season, less frequently in the autumn and spring, and very rare in summer. When well developed they last at least twelve hours, but not often more than twenty-four hours, twelve hours being about the average. The greatest velocity is often attained between midnight and 3 a. m., and generally they are quite as violent, if not more so, at night as in the daytime. The favorite time for the gale to commence is sundown, and there seems to be some connection between their beginning and ending and the rising or setting of the sun. No considerable amount of rain or snow ever occurs with these gales, as their commencement is synonymous with the clearing up of a storm, when the wind shifts from southwest to northwest and the clouds break away. As soon as the gales begin the clouds, which are always of the character of fracto-stratus, fracto-nimbus, or fracto-cumulus, begin to move from the northwest with a much increased and great velocity. The gale sometimes begins below and does not affect the cloud level until later, but more often the clouds show it first. Sometimes the upper clouds begin to move from the northwest, while the lower storm clouds are still moving from southwest. In this case the latter clouds moving from the southwest are gradually pushed southeastward by the northwest wind, and sometimes thrown into rolls stretching arch-like from northeast to southwest. In all cases the clouds present an extremely torn and ragged appearance like all clouds torn by high winds; the different portions of the cloud move in different directions, the upper part forward, the lower backward. Gradually the clouds diminish in size till the air becomes perfectly clear. The altitude of these clouds always exceeds 5,000 feet above sea level. Although they may touch the ground before the gale commences they never do so during the gale.

The actual velocity of the gusts in these gales must often equal 60 miles per hour during a few seconds, the velocity varying greatly, from a light breeze one minute to a hurricane velocity the next. A marked feature is the lack of uniformity horizontally. The gale blows in gusts of a few rods in extent, and these gusts do not always move straight ahead, but whirl and eddy and show all the phenomena of a stream flowing over a rocky bed where the water runs in all directions and is thrown into eddies innumerable, but still pursues a general course.

As soon as the gale begins, the relative humidity of the air rapidly falls, often to 20 per cent or lower. These gales usually are attended by a rapid fall of temperature, and sometimes by a severe cold wave, the lowest temperature occurring when the gale stops. Whether warming by dynamic compression ever occurs in descending the eastern slope to the Piedmont region, is a question. Sometimes, but rarely, a marked rise in temperature is noted, usually in the spring.

The foehn effect that is noted by Abbe as occurring on the eastern slope is a question I have not, therefore, been able to decide. It is stated by him that when west winds with clearing weather occur the rain ceases at such Piedmont stations as Charlotte and Atlanta some time before the same clearing weather occurs at Washington on account of the foehn effect, although the temperature effect (rise) is slight.

The weather maps have been studied in reference to the conditions causing these gales, etc. The following conditions have always been noted on the dates of gales, viz:

[1] See REVIEW, January, 1897, page 18, and December, page 545.

1. A low pressure or cyclone on the east of a line running north and south and passing through this station.

2. A comparatively steep barometric gradient on the west of the line.

3. Clearing weather and *brisk* winds, but not usually gales, at Augusta, Charlotte, Atlanta, and Chattanooga.

It is thus seen that the conditions that produce northwest gales here are the same as produce northwest winds everywhere; but the difference here is in the fact that a gale occurs at my station when only a fresh or brisk wind is noted elsewhere. The velocity of the winds on the eastern slope of the Blue Ridge is greater than the barometric gradient calls for.

It seems to me that the reason for this may be that the slope of the land *increases the velocity* of the cold, heavy air flowing down an inclined surface, just as the swiftness of a stream is increased in proportion as the bed is steeper. I can not say whether the velocity of winds is commonly increased in this manner, but this is the only reason I can think of to explain the gales. It would seem, therefore, that this is a case resembling the bora wind, the velocity being caused by the descent in that case.

These winds resemble the foehn in their extreme dryness, but I am unable to say whether they are drier than ordinary northwest winds in general. The problem is, therefore, this: Why do severe gales occur on the eastern slope of the Blue Ridge and upper Piedmont region when only *brisk* winds are noted at surrounding stations?

HYDROLOGY OF THE LAKE MINNETONKA WATERSHED.

By GEO. W. COOLEY, C. E., Minneapolis, Minn.

Lake Minnetonka covers an area of 23 square miles and receives its supply from an area of 115 square miles. It is situated in Hennepin County, Minn., at an elevation of 915 feet above sea level and is from 8 to 20 miles west of Minneapolis, the metropolis of the State. Its central point is located in latitude 44° 56′ N. and longitude 93° 36′ W.

The basin is of glacial formation, and its surface is rolling, interspersed with many marshes of irregular outline and varying extent, and was formerly covered with a large body of timber known as the "big woods." The surface soil is from 1 to 2 feet in depth, of rich loam, with a clay subsoil of unknown depth.

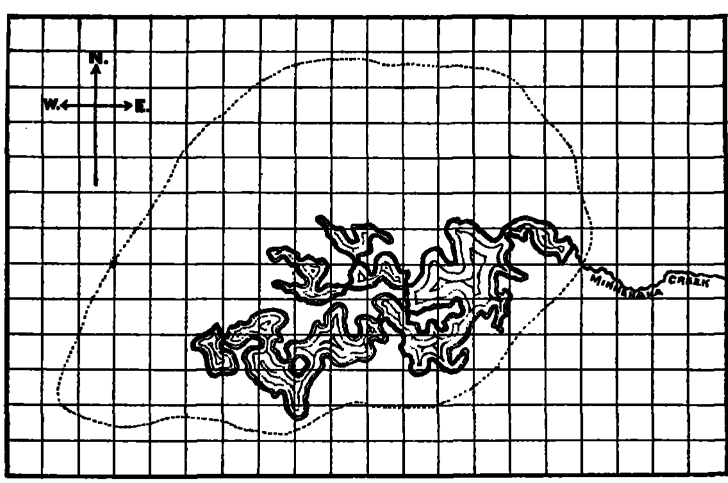

FIG. 1.—Outine of lake and watershed. (Each square represents 1 mile.)

There are occasionally found pockets of sand throughout the basin, but none of great extent, nor any that can be traced as water-carrying strata. In 1864, the year of the writer's first acquaintance with this watershed (which knowledge was considerably enlarged by surveys and explorations during subsequent years), the amount of forest land was approximately 75 per cent of the entire land area. At present it hardly exceeds 20 per cent, the loss occurring entirely through the cultivation of its fertile soil.

By reference to Fig. 1 it will be seen that the outline of the lake is very irregular, with an extreme breadth of 5 miles and a length of 11 miles, the shore line is almost exactly 100 miles in extent, a feature which will be found of considerable importance in determining the proportion of precipitation which enters the lake from the adjacent land.

During the years 1894 and 1895 the writer made a series of soundings covering the entire lake, aggregating many thousands in number, for the purpose not only of determining the depth but also the character of the bottom. The depth in the larger portion of the lake was from 30 to 100 feet, the former being a fair average for the entire lake. The bottom was found invariably covered with vegetable matter and soft mud, which deposit has been produced by the washings from the hillsides and the decay of vegetable matter growing in the lake, and which has resulted in making the bed of the lake literally water-tight. I am so well satisfied from long-continued observations of the imperviousness of this bed that I have not allowed the factor of infiltration to enter into my calculations.

There are no springs of any consequence within several miles of the lake except that known as Purgatory, situated about two miles from its southeastern extremity and about one mile outside the watershed. It was supposed for years by many residents that this spring received its supply through underground sources from the lake, but a careful survey demonstrated the fact that its supply was received from an independent drainage area, mainly covered with tamarack swamp and meadows, which served to produce a fairly regular flow.

With the foregoing description in mind we will proceed to consider the conditions of supply and discharge.

RAINFALL.

The average rainfall at Minneapolis and Lake Minnetonka from 1881 to 1898, inclusive, is 28.14 inches, which latter figure has been used in my calculations, as it was during these years only that the records of rise and fall were kept. The rainfall by years was as follows:

Years.	Yearly.	Summer.	Winter.	Years.	Yearly.	Summer.	Winter.
	Inches.	*Inches.*	*Inches.*		*Inches.*	*Inches.*	*Inches.*
1881.........	34.73	27.33	5.58	1890.........	27.08	22.18	5.49
1882.........	22.95	16.11	7.28	1891.........	26.97	17.82	7.63
1883.........	26 98	21.00	6.41	1892.........	37.90	33.11	6.71
1884.........	29.68	22.81	4.32	1893.........	32.17	23.35	7.42
1885.........	26.66	23.42	6.97	1894.........	22.80	17.17	3.54
1886.........	29.58	20.65	8.16	1895.........	21.44	18.85	4.36
1887.........	32.79	23.80	9.53	1896.........	30.65	22.77	10.11
1888.........	30.12	24.24	4.53	1897.........	30.50	23.82	4.24
1889.........	18.36	12.55	6.34	1898.........	25.77	21.10	....

Making an average yearly fall, as before stated, of 28.14 inches, which I have divided, as above, into two parts, showing the fall during that part of the year when the lake was open and in that part when it was covered with ice, the latter period generally comprising the months of November, December, January, February, and March.

The average precipitation in this vicinity for fifty-three years ending with 1898 is 27.29 inches. The earlier years of this period were taken from the Fort Snelling records 20 miles east by south. A large majority were from the Minneapolis observations taken 15 miles east, while those for the past eighteen months were from observations taken at the lake.

The averages for these two periods are 21.78 and 6.39, respectively.